REMARKS

Applicant respectfully requests consideration of the subject application. This Response is submitted in response to the Office Action mailed May 23, 2008. Claims 8, 9, 12-16, 20, and 23-30 are pending. Claims 8, 9, 12-16, 20, and 23-30 are rejected. In this Amendment, claims 8 and 23 have been amended. No new matter has been added.

35 U.S.C. § 103 Rejections

The Examiner has rejected claims 8, 9, 12-16, 20, 23-25 and 27-30 under 35 U.S.C. § 103(a) as being unpatentable over Choi et al. (US 7,029,796, hereinafter "Choi") in view of Dasgupta et al. (US 2003/0152835, hereinafter, "Dasgupta").

Applicant substantially excludes the other steps except for steps (1) ~ (3) of Claims 8 and 23 from the process for preparing a carbon nanotube electrode according to the present application, and thus amends "comprising" to "consisting essentially of."

Such amendment particularly excludes the case of using an organic binder as a binder, thus clarifying the characteristics of the present invention, which intends to overcome the problem generated when an organic binder is used. However, said amendment is merely to clarify the technical characteristic of the present application, and does not intend to exclude obvious equivalents from the

scope of the claims, for example, the case comprising other additional steps within a scope that does not deviate from the technical idea of the present application.

Applicant also amends "from 1 to 500 atm" of Claims 8 and 23 to "from 1 to 500 atm (about 1.033 to about 516.615 kgf/cm^2)."[1] That is, Applicant amends the unit for pressure that was indicated only by "atm" to be indicated together with the unit "kgf/cm^2" according to the common knowledge in the pertinent art. It is clear that 1 atm is 1.03323 kgf/cm^2 (for the sake of convenience, we rounded off the numbers to three decimal points), and thus 500 atm corresponds to about 516.615 kgf/cm^2.

Applicant adds the description "by the binder being bonded, deposited, or fused on the surfaces of the carbon nanotubes" to step (3) of Claims 8 & 23. This amendment is supported by the description in the specification of the present application, at page 14, lines 19-24.

Applicant delete the phrase "wherein the binder has the effect of minimizing the internal resistance of the electrode" recited in step (1) of Claims 8 and 23 and places that at the end of Claims 8 and 23. This is to clarify that the effect that the binder selected from the group consisting of sulfur, metal

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[1] Under the US Patent practice, if the corresponding description must be amended reflecting the amendment to the pressure in the claims as above in parenthesis, please

nanoparticles and both of them minimizes the internal resistance of the electrode is exerted throughout the entire carbon nanotube electrode obtained by the preparation process of the present application.

Further, it appears that the invention recited in the amended Claims 8 and 23 and their dependent claims cannot be easily invented from the cited references by a person having ordinary skill in the art. Hereinafter, we will review this in detail.

A. Claim 8 of the present application recites:

> *"A process for preparing a carbon nanotube electrode, consisting essentially of the steps of:*
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> *(1) preparing an electrode material by mixing carbon nanotubes with a binder selected from the group consisting of sulfur having an average particle size of 1μm or less, metal nanoparticles having an average particle size of 1μm or less and both of them;*
>
> *(2) preparing a pressed electrode material by first pressing the electrode material under a pressure from 1 to 500 atm (about 1.033 to about 516.615 kgf/cm²); and*
>
> *(3) subsequently pressing under a pressure from 1 to 500 atm (about 1.033 to about 516.615 kgf/cm²), or heat-treating at a temperature in the range of the melting point of the sulfur or metal nanoparticles ±200□ in inert gas atmosphere, or simultaneously pressing under the said pressure and heat-treating at the said temperature in inert gas atmosphere the previously pressed electrode*

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amend the specification accordingly.

material that is placed on a current collector so that the carbon nanotubes are bonded to each other and simultaneously bonded to the current collector, by the binder being bonded, deposited, or fused on the surfaces of the carbon nanotubes;

wherein the binder has the effect of minimizing the internal resistance of the electrode."

Also, Claim 23 recites:

"A process for preparing a carbon nanotube electrode, consisting essentially of the steps of:

(1) preparing an electrode material by depositing a binder selected from the group consisting of sulfur having an average particle size of 10m or less, metal nanoparticles having an average particle size of 10m or less and both of them on the carbon nanotubes;

(2) preparing a pressed electrode material by first pressing the electrode material under a pressure from 1 to 500 atm (about 1.033 to about 516.615 kgf/cm²); and

(3) subsequently pressing under a pressure from 1 to 500 atm (about 1.033 to about 516.615 kgf/cm²), or heat-treating at a temperature in the range of the melting point of the sulfur or metal nanoparticles ±200□ in inert gas atmosphere, or simultaneously pressing under the said pressure and heat-treating at the said temperature in inert gas atmosphere the previously pressed electrode material that is placed on a current collector so that the carbon nanotubes are bonded to each other and simultaneously bonded to the current collector, by the binder being bonded, deposited, or fused on the surfaces of the carbon nanotubes;

wherein the binder has the effect of minimizing the internal resistance of the electrode."

In this regard, in order to overcome a technical problem that the internal resistance of the electrode is increased due to the organic binders when preparing carbon nanotubes to fabricate an electrode using conventional organic binders (the present specification at page 12, lines 6-19), the present invention provides electrodes made of carbon nanotubes characterized in that the binding within the electrode material comprising carbon nanotubes as well as between the electrode materials and the current collector is achieved by excluding the use of conventional organic polymers, using only sulfur and/or metal nanoparticles as a binder and by pressing and/or heating the electrode system (see page 12, line 25 to page 13, line 9 of the present specification). That is, in manufacturing electrodes made of carbon nanotubes, the technical feature lies in minimizing the internal resistance of the electrode by using sulfur and/or metal nanoparticles as a binder, which has not been used in the prior art.

Also, when compared with using the conventional organic binder, the advantage of the present invention using sulfur and/or metal nanoparticles as a binder is disclosed in more detail in the specification, at page 19, line 6 - page 21, line 5 in addition to the effect of minimizing the internal resistance of the electrode stated above. For example, the binder of the present invention has advantages that it does not offset the inherent advantages of the carbon nanotube unlike the other conventional binders which deteriorate the inherent advantages of carbon nanotube by completely covering the surface of carbon nanotubes, that

it has an excellent durability than using an organic binder, and that the organic binder can easily dissolve in the electrolyte component or easily react with a strong corrosive electrolyte, not fully performing its role as a binder, but the sulfur and/or metal nanoparticles binder does not.

The examiner states that "the preamble of the claims state that the electrode is being prepared by steps 'comprising of', which is not closed ended and lends itself to including other steps that may not be mentioned." Thus, by the present amendment, the applicant substantially excludes the other steps except for steps (1) - (3) of Claims 8 and 23 from the process for preparing a carbon nanotube electrode according to the present application, and thus amended "comprising" to "consisting essentially of." Thus, by the present amendment, it is obvious that the case of using an organic (or polymer) binder as a binder is excluded.

Choi exemplifies Fig. 2B, and discloses a method of fabricating a positive electrode using a positive active material of sulfur-conductive agent-agglomerated complex. More particularly, the sulfur and conductive agent are mixed (S10) and milled to provide a sulfur-conductive agent-agglomerated complex (S11). Then a binder solution is added thereto to provide slurry of positive active material (S12). A current collector is coated with the slurry (S13) and rolled (S14) to provide a positive electrode plate (column 6 lines 31-40).

Choi is characterized in that in order to solve the problem that if sulfur and conductive agent are simply added to a binder solution to prepare a slurry, the particle size of the sulfur particles is not controlled due to the aggregation of sulfur particles, and the sulfur particles are irregularly distributed in the electrode plate (column 4 line 52 to column 5 line 2), before preparing the slurry, a sulfur-conductive agent-agglomerated complex is first prepared by performing the mechanical milling process, and then slurry is made by adding this into the binder solution (which is an organic binder) (see column 5 lines 3-7, column 6 lines 31-40, Fig. 2A and Fig. 2B). Thus, the present invention differs in the subject matter to be solved or technical idea from Choi.

Further, Choi uses an organic binder such as poly(vinyl acetate), polyvinyl alcohol, polyethylene oxide (column 6 line 56 – column 7 line 3). Choi discloses preparing a slurry by mixing a sulfur-conductive agent-agglomerated complex and such organic binder in a solvent, and then preparing an electrode plate by coating it on a current collector in order to attach the sulfur-conductive agent-agglomerated complex on a current collector. Examples 1- 4 use a binder solution prepared by adding polyethylene oxide to acetonitrile, to prepare a slurry comprising a sulfur-ketjen black agglomerated complex.

Thus, in order to prepare carbon electrodes in accordance with Choi, an organic binder must be used. In the process according to Choi, a bonding cannot be

achieved between the electrode materials, sulfur-conductive agent-agglomerated complex, without using an organic binder. In addition, an electrode where said complex is adhered to the current collector cannot be achieved by simply coating and rolling a solution where sulfur-conductive agent-agglomerated complex is dispersed in the solvent on the current collector without using an organic binder (according to the example, coated by a doctor blade). Thus, from Choi, it is difficult to infer the present invention, which prepares electrodes without using an organic binder, but using sulfur, metal nanoparticles or both of them as a binder.

Referring to each step of the preparation process of electrode, as to step (1) of the present application, in the Office Action at page 3, 6(1), the examiner states "Choi et al. discloses a process for preparing a carbon nanotube electrode for a lithium secondary battery comprising the steps of: (1) preparing an electrode material by depositing a binder selected from the group consisting of sulfur having an average particle size of or less on the carbon nanotube, wherein the binder has the effect of minimizing the internal resistance of the electrode."

However, as disclosed in column 5 lines 23~26, Choi uses a sulfur particle less than or equal to 7 μm, preferably less than or equal to 3 μm, which is larger than the particle used in the present invention (even in the examples, the average size of the sulfur particle is about 3 μm (column 9 lines 45-46), and the conductive

agent (smaller than the sulfur particle) is attached onto the surface of such sulfur powder (column 6 line 15-20). The above can be confirmed from Fig. 3.

In contrast, the present invention uses sulfur particles and/or metal nanoparticles of less than or equal to 1 μm, and the sulfur particle and/or metal nanoparticles having such small size act as a binder by being bonded, deposited or fused on the surface of the carbon nanotube. Thus, when compared with Choi, the present invention differs in the starting material used in step (1), and it also differs in the preparation process and the form of electrode material prepared accordingly.

Also, Choi discloses the sulfur to conductive agent weight ratio as 5-10 : 1, preferably 6-8 : 1 (column 6 line 21-23). However, the sulfur or metal nanoparticles to carbon nanotubes ratio is 0.01-3 : 1 in the present invention (page 14 line 25 to page 15 line 3). Thus, they differ in the content of the sulfur of the electrode material.

Further, with regard to the fact that the binder has an effect of minimizing the internal resistance of the electrode, the present invention does not use an organic binder, and uses only a binder selected from the group consisting of sulfur, metal nanoparticles and both of them to prepare a carbon nanotube electrode, and thus the binder has an effect of minimizing the internal resistance

of the electrode. Such effect can be achieved throughout the carbon nanotube electrode prepared in accordance with the process of the present application. Thus, we moved the description "wherein the binder has the effect of minimizing the internal resistance of the electrode" recited in step (1) to the end of Claims 8 and 23.

However, Choi uses the organic binder rejected to have a problem in the prior art of the specification of the present application as an essential constitutional element, and thus such organic binder cannot achieve the effect of minimizing the internal resistance of the electrode. Choi does not disclose or suggest such effect, and thus it is difficult to accept the examiner's opinion that a reference, which is silent about a claimed invention's features, is inherently anticipatory.

In particular, in the Office Action at page 9 (b), the Examiner states that by manipulating the quantity of the materials used and the type of materials used, it is expected that the capacity and resistance ratios will change with the change in material from Choi. However, unlike the present invention, Choi has an inherent difference of essentially using an organic binder. Thus, a person having ordinary skill in the art cannot easily adopt the constitution of excluding an organic binder and using only sulfur and/or metal nanoparticles as a binder from Choi. Thus, from the effect disclosed in Choi, it is very difficult to infer the particular effect of

the present application as mentioned above without using an organic binder. The tests shown in the specification at pages 30-31 support the excellent effect of the present invention.

With regard to step (2) of the present application, in the Office Action at page 4, 6(2), the examiner states "Choi discloses preparing a pressed electrode material by providing the agglomerated complex onto a current collector and rolling it to provide an electrode plate. The rolling process will occur with a pressure of at least 1 atm, since 1 atm is considered standard pressure."

However, Choi relates to a method for attaching the agglomerated complex to the surface of the current collector, and merely discloses at column 6, lines 39-40 that "A current collector is coated with the slurry (S13) and rolled (S14) to provide a positive electrode plate," [1], and the examples (column 9 lines 53-55) merely disclose coating the slurry on the surface of the Al current collector by a doctor blade, but does not mention compressed pressure at all. As can be seen from the drawing below, the coating using the doctor blade used in Choi et al. merely coats the slurry in a certain thickness under atmosphere, and this is different from pressing by directly adding pressure to the electrode material of solid powder phase that is not slurry as the present invention.

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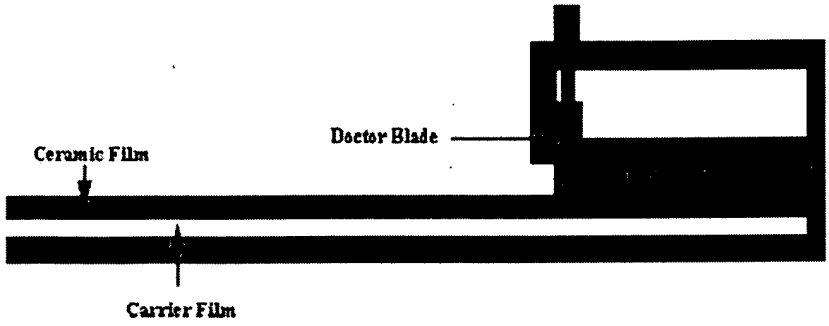
[1] Unlike said description, Fig. 2A and Fig. 2B of Choi discloses "compressing" after coating the slurry, and thus they are not consistent.



Also, all processes such as rolling or pressing, etc. are performed under atmosphere, which is 1 atm. However, 1-500 atm recited in Claims 8 and 23 of the present application means gauge pressure, not absolute pressure. That is, in order to achieve the binding of carbon nanotubes by sulfur and/or metal nanoparticles, pressure is added directly by a machine in addition to the atmosphere to the electrode material prepared in step (1), and said pressure means the total force added per the unit area of the electrode surface. Through the present amendment, the applicant clarified that steps (2) and (3) of the present application is not a step of rolling or coating a slurry material under atmosphere as Choi, but is a step of pressing by directly adding pressure of 1 - 500 atm, i.e., a gauge pressure of about 1.033 ~ about 516.615 kgf/cm^2, in addition to the atmosphere, to a solid electrode material through a press.

Further, the present invention does not prepare a form of slurry comprising the agglomerated complex and an organic binder as Choi, and thus does not coat or attach it on the surface of the current collector. Referring to

Claims 14 and 27 or Examples 1-9 of the present application, pressed electrode material is achieved in the form of a disk or film by pressing the electrode material in solid powder phase prepared by mixing or depositing the carbon nanotubes with sulfur and/or metal nanoparticles binder. Thus, it cannot be considered that Choi discloses step (2) of the present application.

In the Office Action at pages 4~5, the examiner states that Dasgupta discloses preparing an electrode material by mixing nanometer sized carbon tubes or nanofibers with spherical graphite, which contain about 1.5% to 15% carbon nanotubes, with a binder; preparing a pressed electrode material by first pressing the graphite/carbon nanotube/binder mixture into a pressed compact with copper foil on one side; and subsequently heat-treating temperature range being from 40°C to 85°C.

However, Dasgupta relates to "an anode for a lithium battery having a conductive substrate coated with a pressed compact of spherical graphite and an ion conduction polymeric binder." (see [0023] and Claim 1 of Dasgupta). As in Choi, Dasgupta merely discloses an ion-conducting polymeric binder. Also, Dasgupta does not disclose the use of sulfur and/or metal nanoparticles. In particular, it does not disclose using them as a binder. Also, the examples use a polyvinylidene fluoride binder sold at Kynar, which is an organic binder.

Dasgupta uses an organic binder as an essential constitutional element, and without using this, it cannot achieve negative electrode.

In contrast, the present invention uses only sulfur and/or metal nanoparticles as a binder, and the carbon nanotubes are bonded to each other and simultaneously bonded to the current collector by bonding, depositing or fusing this binder on the surface of the carbon nanotubes. Thus, when compared with Dasgupta, the present invention differs in starting material used at the time of preparing the electrode material, and it also differs in the preparation process and the form of electrode material prepared accordingly.

In the Office Action at page 9, the examiner states that carrying out the heat treatment under vacuum is done in a non-reactive atmosphere, which is the same type of atmosphere that is obtained by using an inert atmosphere. However, as can be seen in Example 1-3 (paragraph [0030]-[0032]), the heat treatment disclosed in Dasgupta at paragraphs [0014], [0015], [0016], [0027] and [0028] is performed before spreading the paste on the current collector. The heat treatment disclosed in Dasgupta at paragraphs [0015] and [0027] is for processing the carbon nanofibers before mixing the electrode materials, and the heat treatment disclosed in Dasgupta at paragraphs [0016] and [0028] is performed to a paste prepared by mixing the electrode material and organic binder and wetting this mixture with electrolyte, in order to perform heat treatment to the

carbon nanofibers in a paste at 45-80°C which does not damage the organic materials, as disclosed in paragraph [0014] and Claims 5 and 6. That is, contrary to the examiner's rejection, Dasgupta first performs heat treatment of the paste, and then performs spreading to the electrode in the form of a pressed compact with current collector on one side.

In contrast, the present invention molds the solid electrode material by first pressing after mixing or depositing the electrode material with sulfur and/or metal nanoparticles, and then performs pressing and/or heat treatment in order to bond the electrode materials. That is, Dasgupta differs from the procedure and purpose in performing the heat treatment after mixing and pressing the electrode material as in the present invention. Thus, it cannot be considered that Dasgupta discloses the process for preparing the electrode of the present invention.

Also, even though Dasgupta discloses "an anode for a lithium battery having a conductive substrate coated with a pressed compact of spherical graphite and an ion conducting polymeric binder," it does not disclose the detailed pressure the pressing was performed. In the Office Action at page 5, the examiner states that 1 atm is a standard pressure, and thus it is obvious to a person having ordinary skill in the art that pressing is performed in the range of 1-500 atm. However, 1-500 atm recited in Claims 8 and 23 of the present

application means gauge pressure, not absolute pressure. In order to achieve the binding of carbon nanotubes and current collector by sulfur and/or metal nanoparticles, the pressed electrode material prepared in step (2) is placed on the current collector, and pressure is added directly by a machine in addition to atmosphere. That is, said pressure means the force added per the unit area of the electrode surface. The pressed compact of Dasgupta is achieved by spreading the paste comprising an organic binder on the current collector. However, the present invention presses the solid first pressed electrode material by a press, in addition to atmosphere, to 1 ~ 500 atm, i.e., about 1.033 ~ about 516.615 kgf/cm^2. This has been clarified by the present amendment. Thus, the process of pressing under a gauge pressure of 1 ~ 500 atm (about 1.033 to about 516.615 kgf/cm^2) of the present invention clearly differs from that of Dasgupta.

In conclusion, Dasgupta does not disclose or suggest step (3) of the present application, which is a constitution of pressing under a pressure from 1 to 500 atm (about 1.033 to about 516.615 kgf/cm^2), or heat-treating at a temperature in the range of the melting point of the sulfur or metal nanoparticles ±200°C in inert gas atmosphere, or simultaneously pressing under the said pressure and heat-treating at the said temperature in inert gas atmosphere the previously pressed electrode material that is placed on a current collector so that the carbon nanotubes are bonded to each other and simultaneously bonded to the current collector, by the binder being bonded, deposited, or fused on the

surfaces of the carbon nanotubes, and a person having ordinary skill in the art cannot easily infer such process from Dasgupta.

There is no reasonable ground for combining Choi that has different starting materials and a different process for preparing the electrode, and that uses an organic binder, with Dasgupta that does not use sulfur and/or metal nanoparticles at all but uses only polymeric binder, and has a different preparation process. It would be difficult for a person having ordinary skill in the art to combine Choi with Dasgupta that have completely different technical subject matter to be solved or technical idea.

Also, both Choi and Dasgupta must use an organic binder in order to adhere carbon nanotubes on the substrate of the current collector. Thus, even if Choi and Dasgupta are combined, there is no reasonable reason for adopting the constitution of the present application which does not use an organic binder but uses a binder selected from the group consisting of sulfur, metal nanoparticles and both of them, whose average particle size is less than or equal to 1 μm, and a person having ordinary skill in the art cannot easily infer such constitution.

Further, Choi and Dasgupta do not disclose or suggest the particular effect of the present invention presented by not using an organic binder. Thus, a

person having ordinary skill in the art cannot infer the effect of the present invention from Choi and Dasgupta.

As stated above, it is difficult to infer the process for preparing a carbon nanotube electrode recited in the amended Claims 8 and 23 of the present invention by combining Choi and Dasgupta. Also, Claims 9, 12, 14-16, 20, 24, 25 and 27-30 include the contents of Claim 8 or 23 as their technical characteristic.

Applicant, accordingly, respectfully requests withdrawal of the rejections of claims 8-9, 12, 14-16, 20, 23-25 and 27-30 under 35 U.S.C.§103(a), and a Decision for Grant of Patent on the present application.

The Examiner has rejected claims 13 and 26 under 35 U.S.C.§103(a) as being unpatentable over Choi and Dasgupta, as applied to claims 8-9, 12, 14-16 and 20 above, and in further view of Choi et al. (US 2004/001841, hereinafter "Choi (2)").

In this regard, Claim 13 or 26 includes the contents of Claim 8 or 23 as their technical characteristic. Thus, as stated above, said claims have inventive step over Choi and Dasgupta.

With regard to Choi (2), it discloses carbon nanotubes directly grown over a carbon substrate and whose internal and external walls are uniformly doped with catalyst particles of a diameter of a few nanometers or less ([0016]). A method for fabricating such a carbon nanotubes grown over a carbon substrate comprises: uniformly distributing metallic catalyst particles over the carbon substrate; and supplying a carbon source gas at a constant rate under atmospheric pressure and reacting the carbon source gas with the metallic catalyst particles at a temperature of 400-900 for 1-120 minutes to grow carbon nanotubes over the carbon substrate ([0020]). In the method for fabricating carbon nanotubes according to Choi (2), uniformly dispersing the metallic catalyst particles over the carbon substrate may be achieved by electrophoresis, thermal spraying, sputtering, chemical vapor deposition (CVD), and any other techniques common to one of ordinary skill in the art ([0033]).

Thus, in the process disclosed in Choi (2), before the carbon nanotubes are grown on the carbon substrate, metallic catalyst particles are first uniformly distributed over the carbon substrate by the process of electrophoresis. Then, metallic catalyst particles act as a catalyst so that carbon nanotubes grow on the carbon substrate. During said process, metallic catalyst particles are doped on the internal and external walls of the carbon nanotubes. Even in the examples of Choi (2), after metallic catalyst particles are uniformly distributed on the surface of the carbon substrate, carbon nanotubes grow on the carbon substrate.

That is, Choi (2) merely discloses metal particles as a catalyst used when growing carbon nanotubes, but does not disclose or suggest the use of metal particle as a binder for binding carbon nanotubes. Thus, even a person having ordinary skill in the art cannot easily derive using sulfur and/or metal nanoparticles as a binder instead of an organic binder for preparing an electrode material from Choi.

Also, Choi (2) and the present invention clearly differ in the principle of solving a problem and technical idea. In particular, a person having ordinary skill in the art cannot easily combine Choi (2)and Choi and Dasgupta which do not disclose using sulfur, metal nanoparticles, or both of them as a binder.

Further, Choi (2), Choi and Dasgupta do not disclose or suggest the remarkable effect of the present invention which does not use an organic binder. Thus, a person having ordinary skill in the art cannot infer the particular effect of the present invention even by combining the cited references.

Applicant, accordingly, respectfully requests withdrawal of the rejections of claims 13 and 26 under 35 U.S.C.§103(a).

Applicant respectfully submits that the present application is in condition for allowance. If the Examiner believes a telephone conference would expedite or assist in the allowance of the present application, the Examiner is invited to call Stephen M. De Klerk at (408) 720-8300.

Please charge any shortages and credit any overages to Deposit Account No. 02-2666. Any necessary extension of time for response not already requested is hereby requested. Please charge any corresponding fee to Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: August 15, 2008

/ Stephen M. De Klerk /

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